Contents

Useful Links

COSMED Homepage

http://www.cosmed.com

K4 b² Page

http://www.cosmed.com/k4b2

K4 b²

General

Validation of the COSMED K4 b2 portable metabolic system.

McLaughlin JE, King GA, Howley ET, Bassett DR Jr, Ainsworth BE. Int J Sports Med. 2001 May;22(4):280-4.

PURPOSE: The purpose of this investigation was to assess the accuracy of the COSMED K4 b2 portable metabolic measurement system against the criterion Douglas bag (DB) method.

METHODOLOGY: During cycle ergometry on consecutive days, oxygen consumption (VO2), carbon dioxide production (VCO2), minute ventilation (VE), and respiratory exchange ratio (R) were measured at rest and during power outputs of 50, 100, 150, 200, and 250W.

RESULTS: No significant differences ($P > 0.05$) were observed in VO2 between the K4 b2 and DB at rest and at 250W. Though the K4 b2 values were significantly higher ($P<0.05$) than DB values at 50, 100, 150, and 200 W, the magnitude of these differences was small (0.088, 0.092, 0.096, and 0.088 L x min(-1), respectively). VCO2 and VE values from the K4 b2 were significantly lower than the DB at 200 and 250 W, while no significant differences were observed from rest through 150W. The slight overestimation of VO2 (50-200 W) combined with the underestimation of VCO2 (200 and 250W) by the K4 b2 resulted in significantly lower R values at every stage.

CONCLUSIONS: These findings suggest the COSMED K4 b2 portable metabolic measurement system is acceptable for measuring oxygen uptake over a fairly wide range of exercise intensities.

Test-retest reliability of a portable gas analysis system under free living conditions

Sundar Kumar Veluswamy, Vasudeva Guddattu and Arun G. Maiya. Indian J Physiol Pharmacol 2015; 59(1) : 117–120

PURPOSE: Evaluate the test-retest reliability of K4b2 during walking, stair climbing and descending stairs under free living conditions.

METHODOLOGY: Twelve participants completed two self-selected comfortable paced walking tests and 20 participants completed two self-selected comfortable paced stair climbing and descending tests. VO2 and VCO2 were measured during the tests using K4b2.

RESULTS: ICCs for VO2 (ICC & 95% CI: 0.91, 0.72-0.97) and VCO2 (0.91, 0.72-0.97) of walking demonstrated high reliability whereas reliability was moderate for stair climbing (VO2: 0.82, 0.6-0.93; VCO2: 0.73, 0.44-0.88) and low for descending stairs (VO2: 0.67, 0.33-0.85; VCO2: 0.51, 0.1-0.77).

CONCLUSIONS: K4b2 is a highly reliable device for VO2 and VCO2 measurement during self-paced walking in free living environment.

Validity and reliability of a new portable telemetric calorimeter designed to measure oxygen consumption and carbon dioxide production.

De Lorenzo A, Sorge RP, Bertini I, Andreoli A, Iacopino L, Di Daniele N, Perriello G. Diabetes Nutr Metab. 2001 Oct;14(5):268-76.

PURPOSE: The purpose of the present study was to evaluate the precision and the accuracy of a new portable telemetric calorimeter developed for the measurement of oxygen consumption, carbon dioxide production and pulmonary ventilation.

METHODOLOGY: An experimental protocol was designed to generate a series of tidal volumes (from 100 ml to 6000 ml at 200 ml steps) at different respiratory rates (5, 8, 14, 20, 40, 60, 75 breaths-min(-1)). For this purpose, a standardized pulmonary waveform generator system was utilized. Moreover, in order to evaluate the measure of O2 and CO2 concentrations at different temperatures (-10 degrees, 0 degrees, 15 degrees, 25 degrees, 40 degrees C), the instrument was placed inside an adjustable temperature and humidity chamber.

RESULTS: The accuracy of flow measurements was within +/-3% in respect to the real values throughout the entire range of physiological values, whereas the measurements of gas concentrations were within +/-1% between 0 and 25 degrees C.

CONCLUSIONS: The new portable telemetric calorimeter represents an easy to use instrument for the measure of energy expenditure during the activities of daily living.

COSMED
The Metabolic Company

Running

The level of accuracy and agreement in measures of FEO2, FECO2 and VE between the Cosmed K4b2 portable, respiratory gas analysis system and a metabolic cart.

Pinnington HC, Wong P, Tay J, Green D, Dawson B. J Sci Med Sport. 2001 Sep;4(3):324-35.

PURPOSE: This study aimed to assess the accuracy of the Cosmed K4b2 (Cosmed, Italy) portable metabolic system that measures FEO2, FECO2 and VE on a breath by breath basis.

METHODOLOGY: For gas concentration comparisons, expired air from 20 subjects performing treadmill running was collected in a 600 litre chain compensated Collins Tissot tank and analysed for FEO2 and FECO2 using a laboratory metabolic cart and the Cosmed K4 b2 metabolic system. For ventilation comparisons, serial steady state VE (STPD) values were measured on 10 subjects using the Cosmed K4b2 ventilation turbine and a Morgan ventilation monitor during a continuous treadmill running protocol at ascending speeds of 8, 11 and 14 km x h(-1).

RESULTS: The Cosmed K4b2 FEO2 and FECO2 measures were significantly lower ($P < 0.001$) than the metabolic cart values. Pearson correlation coefficients (r) and the standard error of measurement (SEM) demonstrated a high association between the Cosmed and the metabolic cart measures (FEO2 r =0 .971, SEM 0.071: FECO2 r = 0.925, SEM 0.087). Cosmed VE (l x min(-1)) measures were significantly greater than Morgan values at running speeds of 8 kmh(-1) ($P < 0.001$) and 11 kmh(-1) ($P < 0.001$) but not significantly different at 14 km x h(-1) ($P > 0.05$). When VE measures at the three running speeds were combined, the mean difference between instrument measures ranged between 3.5 - 4.0 l x min(-1) but the values were highly correlated (r= 0.982, $P<0.01$; SEM 3.03). Linear regression analysis revealed the following regression equations to predict metabolic cart values from Cosmed measures: FEO2 = 0.852+0.963 Cosmed (R2 = 0.940, $P<0.00$ 1), FECO2 = 0.627+0.878 Cosmed (R2=0.856, $P<0.001$), VE = -2.50+0.984 Cosmed (R2 = 0.965. $P < 0.001$).

CONCLUSIONS: The results indicated that the Cosmed K4b2 unit assessed here produced measures of FEO2, FECO2 and VE that had strong correlation to values obtained from a metabolic cart. However, linear regression analysis may further improve the accuracy of Cosmed K4b2 measures when compared to metabolic cart values.

Comparative analysis of the Cosmed Quark b2 and K4b2 gas analysis systems during submaximal exercise.

Eisenmann JC, Brisko N, Shadrick D, Welsh S. J Sports Med Phys Fitness. 2003 Jun;43(2):150-5.

PURPOSE: The purpose of this study was to compare the Cosmed K4b2 portable gas analysis system with the Cosmed Quark b2 metabolic cart.

METHODOLOGY: Twenty-one subjects attended one testing session that consisted of duplicate measurements of gas volumes and concentrations using both Cosmed gas analysis systems at 3 treadmill work rates; 1) 80m x min(-1), 0% grade, 2) 80m x min(-1), 5% grade, and 3) 80m x min(-1), 10% grade. Subjects walked for 3 min at each rate with one of the gas analysis systems attached to the facemask. The order of the procedures was randomized so that one system was used during both phases (1st or 2nd) of each work rate.

RESULTS: The results indicated that oxygen consumption (VO2) was significantly higher in the K4b2 compared to the Quark at 80m x min(-1), 0% grade (14.3+/-1.2 vs 13.6+/-1.2ml x kg(-1) x min(-1), respectively), ($p<0.01$). The fractional concentration of oxygen in expired air was also significantly lower in the K4b2 at 80 m x min(-1), 0% grade and 80 m x min(-1), 10% grade ($p<0.05$). There were no significant differences between systems for minute ventilation or carbon dioxide production. Despite the small mean bias in mean VO2 values (0.5-1.0ml x kg-1 x min(-1) higher) in the K4b2, all individual values were within the limits of agreement (mean difference+/-2 SD) as determined by the Bland-Altman technique.

CONCLUSIONS: The findings show a minimal bias in respiratory and metabolic parameters during bi-pedal locomotor activities at low to moderate exercise intensities in the two gas analysis systems.

Walking

Comparison of the Cosmed K4b2 Portable Metabolic System in Measuring Steady-State Walking Energy Expenditure

Jennifer A. Schrack, Eleanor M. Simonsick, and Luigi Ferrucci. PLoS One. 2010; 5(2): e9292.

PURPOSE: Recent introduction of the Cosmed K4b2 portable metabolic analyzer allows measurement of oxygen consumption outside of a laboratory setting in more typical clinical or household environments and thus may be used to obtain information on the metabolic costs of specific daily life activities. The purpose of this study was to assess the accuracy of the Cosmed K4b2 portable metabolic analyzer against a traditional, stationary gas exchange system (the Medgraphics D-Series) during steady-state, submaximal walking exercise.

METHODOLOGY: Nineteen men and women (9 women, 10 men) with an average age of 39.8 years (±13.8) completed two 400 meter walk tests using the two systems at a constant, self-selected pace on a treadmill. Average oxygen consumption (VO2) and carbon dioxide production (VCO2) from each walk were compared.

RESULTS: Intraclass Correlation Coefficient (ICC) and Pearson correlation coefficients between the two systems for weight indexed VO2 (ml/kg/min), total VO2 (ml/min), and VCO2 (ml/min) ranged from 0.93 to 0.97. Comparison of the average values obtained using the Cosmed K4b2 and Medgraphics systems using paired t-tests indicate no significant difference for VO2 (ml/kg/min) overall ($p = 0.25$), or when stratified by sex ($p = 0.21$ women, $p = 0.69$ men). The mean difference between analyzers was – 0.296 ml/kg/min (±0.26). Results were not significantly different for VO2 (ml/min) or VCO2 (ml/min) within the study population ($p = 0.16$ and $p = 0.08$, respectively), or when stratified by sex (VO2: $p = 0.51$ women, $p = 0.16$ men; VCO2: $p = .11$ women, $p = 0.53$ men).

CONCLUSIONS: The Cosmed K4b2 portable metabolic analyzer provides measures of VO2 and VCO2 during steady-state, submaximal exercise similar to a traditional, stationary gas exchange system.

Test–Retest Reliability and Minimum Detectable Change Using the K4b2: Oxygen Consumption, Gait Efficiency, and Heart Rate for Healthy Adults During Submaximal Walking

Benjamin J. Darter, Kelly M. Rodriguez, and Jason M. Wilken. Res Q Exerc Sport. 2013 Jun; 84(2): 223–231.

PURPOSE: Oxygen consumption (VO2; mLO2/kg/min), gait efficiency (GE; mlO2/kg/m) and heart rate (HR; beats per minute) are measures of physiological gait performance. However, the collection device, procedures for data normalization, and biological factors can affect measurement variability. The purpose of this study was to determine the test–retest reliability and minimum detectable change (MDC) for VO2, GE, and HR with the K4b2 at submaximal walking speeds in healthy young adults. A second purpose was to determine if net measures improved reproducibility.

METHODOLOGY: Twenty-two participants completed 2 identical treadmill tests on separate days at submaximal walking speeds from 0.71 m/s to 1.65 m/s.

RESULTS: Intraclass correlation coefficient (ICC) values for gross VO2, gross GE, and HR were greater than .85 for all walking speeds. Associated MDC values were approximately 7% to 10% for gross VO2 and GE, and approximately 9% to 12% for HR. ICC values for resting VO2 were lower, with MDC values approaching 25%. Subtracting out resting values to derive net VO2 and GE values produced ICC values below.76 for the 2 slowest speeds but ICC values greater than .83 for the faster speeds. MDC values for net VO2 and GE were up to 20% for the slowest speeds.

CONCLUSIONS: The results demonstrate metabolic cost can be assessed reliably using the K4b2 during submaximal walking and that gross measures are more reliable than net measures. Furthermore, changes at self-selected speeds exceeding 1.0 mLO2/kg/min in gross VO2 and 0.01 mLO2/kg/m in gross GE can be considered a true change in walking performance.

Swimming (with Aquatrainer)

Is the new AquaTrainer® snorkel valid for VO2 assessment in swimming?

Baldari C, Fernandes RJ, Meucci M, Ribeiro J, Vilas-Boas JP, Guidetti L. Int J Sports Med. 2013 Apr;34(4):336-44. doi: 10.1055/s-0032-1321804. Epub 2012 Oct 5.

PURPOSE: The Cosmed AquaTrainer® snorkel, in connection with the K4b2 analyzer, is the most recent instrument used for real time gas analysis during swimming. This study aimed to test if a new AquaTrainer® snorkel with 2 (SV2) or 4 (SV4) valves is comparable to a standard face mask (Mask) being valid for real time gas analysis under controlled laboratory and swimming pool conditions.

METHODOLOGY: 9 swimmers performed 2 swimming and 3 cycling tests at 3 different workloads on separate days. Tests were performed in random order, at constant exercise load with direct turbine temperature measurements, breathing with Mask, SV4 and SV2 while cycling, and with SV2 and SV4 while swimming.

RESULTS: A high agreement was obtained using Passing - Bablok regression analysis in oxygen consumption, carbon dioxide production, tidal volumes, pulmonary ventilation, expiratory fraction of oxygen and carbon dioxide, and heart rate comparing different conditions in swimming and cycling. Proportional and fixed differences were always rejected (95% CI always contained the value 1 for the slope and the 0 for the intercept).

CONCLUSIONS: In conclusion, the new SV2 AquaTrainer® snorkel, can be considered a valid device for gas analysis, being comparable to the Mask and the SV4 in cycling, and to the SV4 in swimming.

Validity of a swimming snorkel for metabolic testing.

Rodríguez FA, Keskinen KL, Kusch M, Hoffmann U. Int J Sports Med. 2008 Feb;29(2):120-8. Epub 2007 Oct 24.

PURPOSE: Two models of a swimming snorkel connected to a portable metabolic cart (Cosmed K4 b2, Rome, Italy) were assessed using a gas exchange simulation system.

METHODOLOGY: Four standardized testing protocols were designed to mimic different swimming conditions and were performed similarly in three conditions so that both snorkels could be compared to measured values obtained by connecting the simulator directly with the gas analyzer.

RESULTS: Simulated and measured values were highly correlated ($R2 = 0.891$ to 0.998) and in good agreement, with only a small overestimation of expiratory tidal volume (4 %, $p = 0.005$), not large enough to significantly affect the accuracy of ventilation or gas exchange parameters. Values measured using both swimming snorkels also highly correlated with simulated values, particularly for the ventilatory and primary gas exchange variables ($R2 = 0.996$ and 0.998 in both models for $VO2$ and $VCO2$, respectively). A moderate overestimation of $FEO2$ was observed in both models (2.65 % and 2.48 % relative, $p = 0.03$) and attributed to minimal mixing of inspiratory and expiratory gases, although not affecting $VO2$ measurements.

CONCLUSIONS: We conclude that both snorkels are valid devices for measuring pulmonary breath-by-breath gas exchange parameters in connection with the K4 b2 across a wide physiological range.